# AP Experiments: Spin-off and Selected Results in Run-5

H. Huang

June 17, 2005

BROOKHAVEN
NATIONAL LABORATORY

# AP Ex: motivation, goals

## GOALS

- Improve machine **performance** (longer time scale than 'now' machine performance) Class1
- **Luminosity**, **upgrade** (RHIC-II) Class 1.5?
- Development of beam **diagnostics techniques**
- Inter-lab **collaborations**
- Class 2 (nothing happened so far)

## RUN5

- Start of experimental activities towards RHIC upgrades
- Limited start of **Class-2** experiments (didn't happen)

BROOKHAVEN NATIONAL LABORATORY

# AP Experiment Categories

**Class:**

**0:** likely to immediately benefit RHIC machine performance, or crucial to RHIC hardware decision-making

**1:** directly benefiting RHIC machine performance

**2:** benefiting general accelerator community

**Priority:**

**A:** a) benefiting RHIC operation; b) well prepared; and c) likely to succeed

**B:** has at least two of the above three

**C:** has at least one of the above three

**D:** none of the above

# AP Ex Program: Run 2005

| | |
|---|---|
| Decoupling on the ramp | Y. Luo |
| AC dipole (coupling) | M. Bai |
| Pressure rise, e-cloud (NEG, new limits) | S.Y.Zhang |
| Stochastic cooling | M. Blaskiewicz |
| Nonlinear (tune spread, IRs) | V. Ptitsyn |
| Beta* squeeze and measurement | F. Pilat |
| Higher order IR corrections | F. Pilat/Y. Luo/N. Malitsky |
| Beam-beam | Tomas/Fischer/Malitsky |
| Polarization | H. Huang/M. Bai |
| PLL experiments | P.Cameron |
| Schottky | K. Vetter |
| IBS | Wei/Fedotov |
| Cryo Jitter | C. Montag |
| RHIC II | V. Litvinenko (?) |
| eRHIC | V. Ptitsyn |

BROOKHAVEN NATIONAL LABORATORY

# New AP Experiments in 2005

1. Anti-grazing rings to study effect on beam loss induced desorption and aperture limitation(P. Theberger, SY).
2. Jet optical signals to study the jet cleanness and beam property (N. Luciano, Dejan)
3. Stochastic cooling (Mike)
4. IBS suppression lattice (Vladimir).
5. Electron cooling related experiments (Ilan).

# Highlights of AP Ex. in Run 05

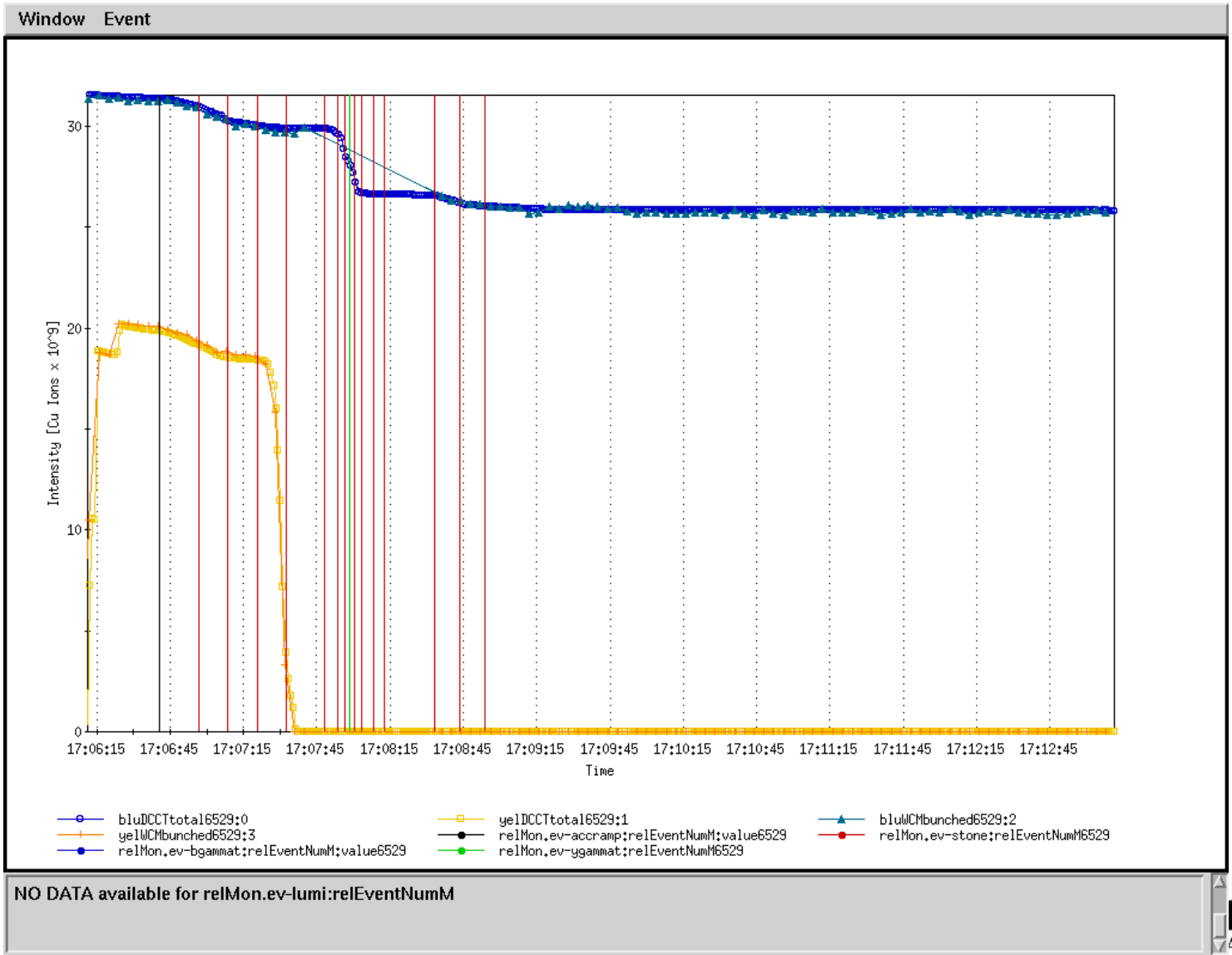
- IBS suppression lattice
- Beta* squeeze at BRAHMS
- Snake Resonance Spectrum
- Transition Study
- Jet camera
- Stochastic cooling
- Decoupling
- IBS measurements
- Beam Based Alignment
- …….

# AP Ex. List for 2005

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 05-01 | Transition Pressure Rise | Ptitsyn | 0 | B | | proposed | instability study? 1B |
| 05-02 | 10 Hz beam jitter as function of He flow | Montag | 1 | B | 2h @end | proposed | end of run |
| 05-03 | Measurement and minimization of local coupling at store using AC dipoles | Tomas | 1 | B | ?? | needs resubmission | |
| 05-04 | Emittance measurement using Schottky | Bai, Kurt, Tepikian | 0+1 | B | (para)+2 | proposed | |
| 05-05 | Molecular desorption under perpendicular impact | Fischer | 2 | B | 2 (Cu) +2 (p) | proposed | |
| 05-06 | Transverse Echoes | Fischer | 1 | B | 3 (Cu)+3 (p) | proposed | |
| 05-07 | Snake Resonance Spectrum | Bai, Roser | 1 | B | 4+4 (p) | proposed | |
| 05-08 | Surviving electrons in gaps | Drees, Jimenez | 1 | | FY06 | proposed | |
| 05-09 | 10 Hz IR orbit feedback test | Montag | 0 | B | 2+2 | proposed | |
| 05-10 | Emittance growth due to 10 Hz beam jitter | Montag | 1 | A | 1+1 | proposed | end of store |
| 05-11 | Skew Quadrupole Modulations | Luo, Pilat | 0 | A | 2+2 | proposed | |
| 05-12 | PLL phase loop test for global decoupling | Cameron, Luo | 1 | B | (para)+2 | proposed | |
| 05-13 | Transverse Impedance Localization | MacKay | 1 | C | 3+3 | proposed | need to link with 04-08 |
| 05-14 | Characterization of Cold Bore Pressure Rise | Hseuh | 0 | A | 2+2 (05-26) | proposed | merge with 05-26 |
| 05-15 | Beta star squeeze at store | Pilat | 0 | B | 2+2 (Cu) 2+2 (p) | proposed | |
| 05-16 | IP optics measurement | Luo | 1 | A | (para) | proposed | |
| 05-17 | Skew Chromaticity II | Tepikian | 1 | C | 2 | proposed | |
| 05-18 | Suppression of transverse IBS | Litvinenko | 0 | C | 8hx2 | proposed | more time likely needed |
| 05-19 | Feasibility Study of Beam-based Alignment in the | Cameron, Kewish | 1 | B | 2h | proposed | |
| 05-20 | Difference between coherent and incoherent tune | Cameron, Wilinski | 1 | B | (para) | proposed | |
| 05-21 | High Frequency Schottky Calibration | Vetter | 0 | B | 2h | proposed | link to 05-04 |
| 05-22 | Evaluation of anti-grazing ridge | Zhang | 1 | B | 2+2 | proposed | |
| 05-23 | NEG pipe evaluation | Huang | 1 | A | 2hx4 | proposed | |
| 05-24 | beam scrubbing | Huang | 1 | C | 8h (p) | proposed | need to extend to cold section |
| 05-25 | Compensation of the 3rd order | Pilat, Ptitsyn | 1 | B | 3hx2 | proposed | |
| 05-26 | Evaluation of electron Cloud in the RHIC arcs | Iriso | 0 | A | (05-26) | proposed | merge with 05-14 |
| 05-27 | Intrabeam scattering coupling dependence | Wei | 1 | A | 6h | proposed | |
| 05-28 | beam based alignment of sextupole | Satogata | 0 | B | 2h | proposed | |

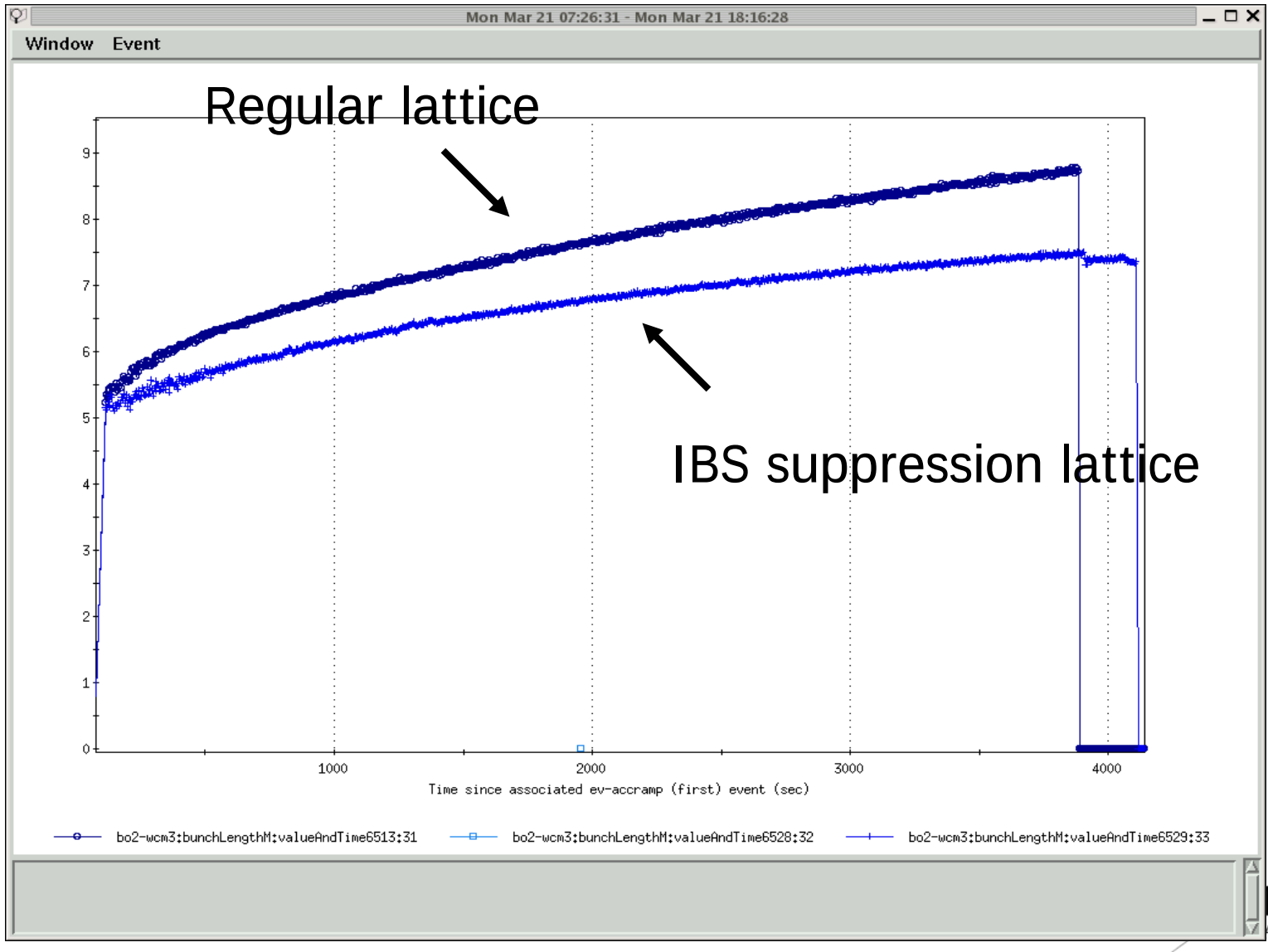
BROOKHAVEN NATIONAL LABORATORY

# IBS Suppression Lattice




HAVEN LABORATORY

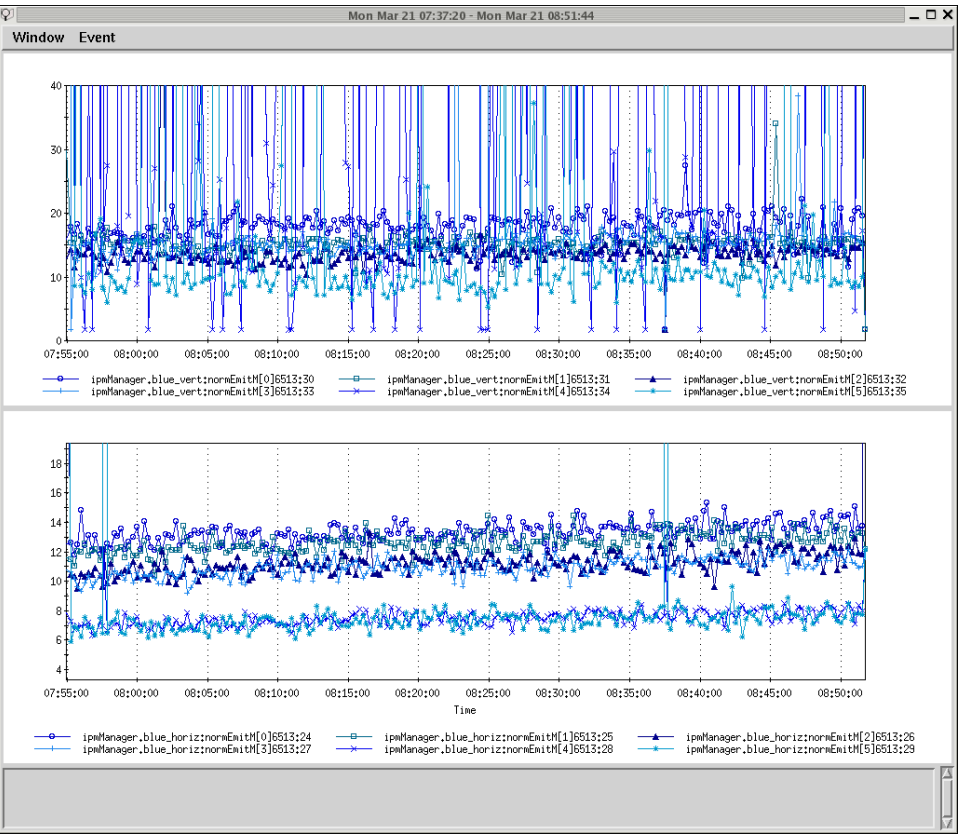
# Bunch Length in Two Ramps

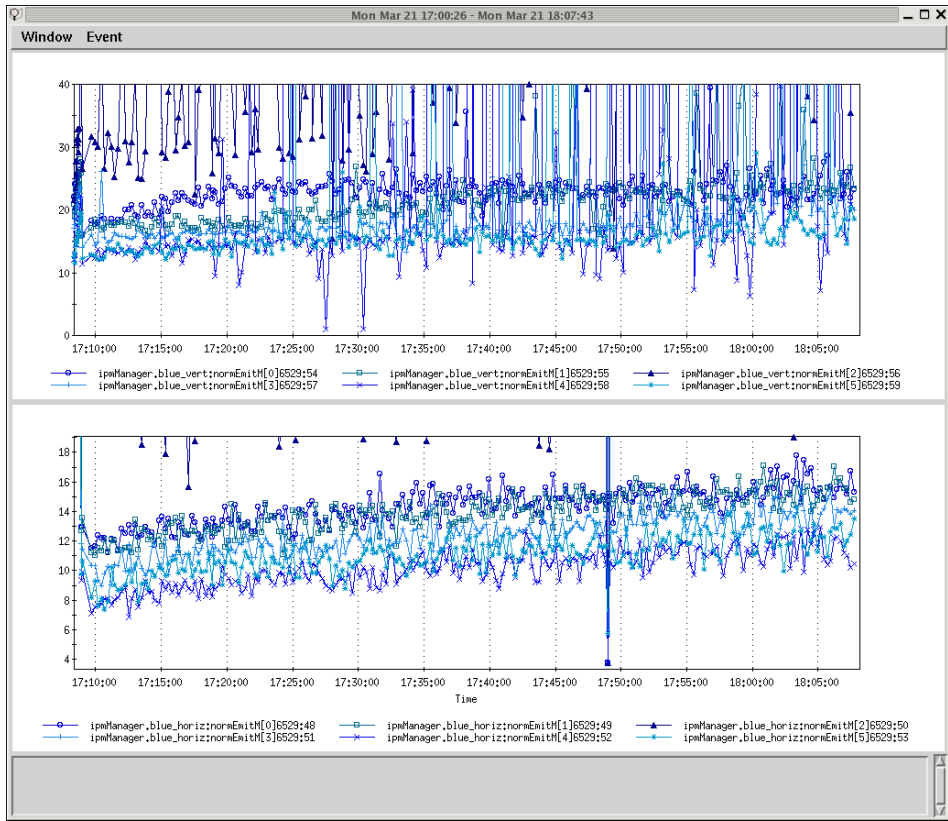


# Transverse Emittances

Regular lattice

IBS suppression lattice



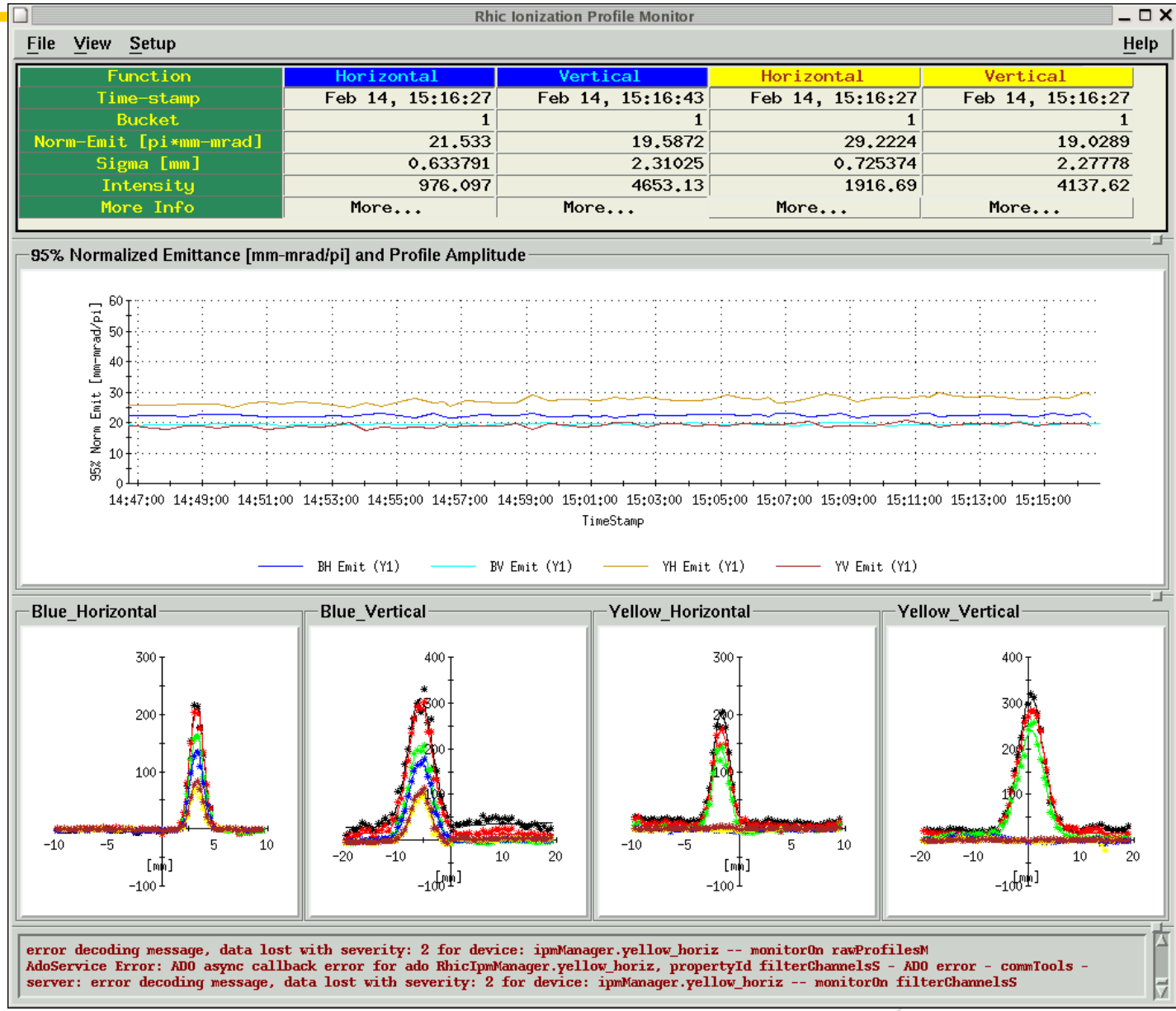

Not same initial emittance

BROOKHAVEN NATIONAL LABORATORY

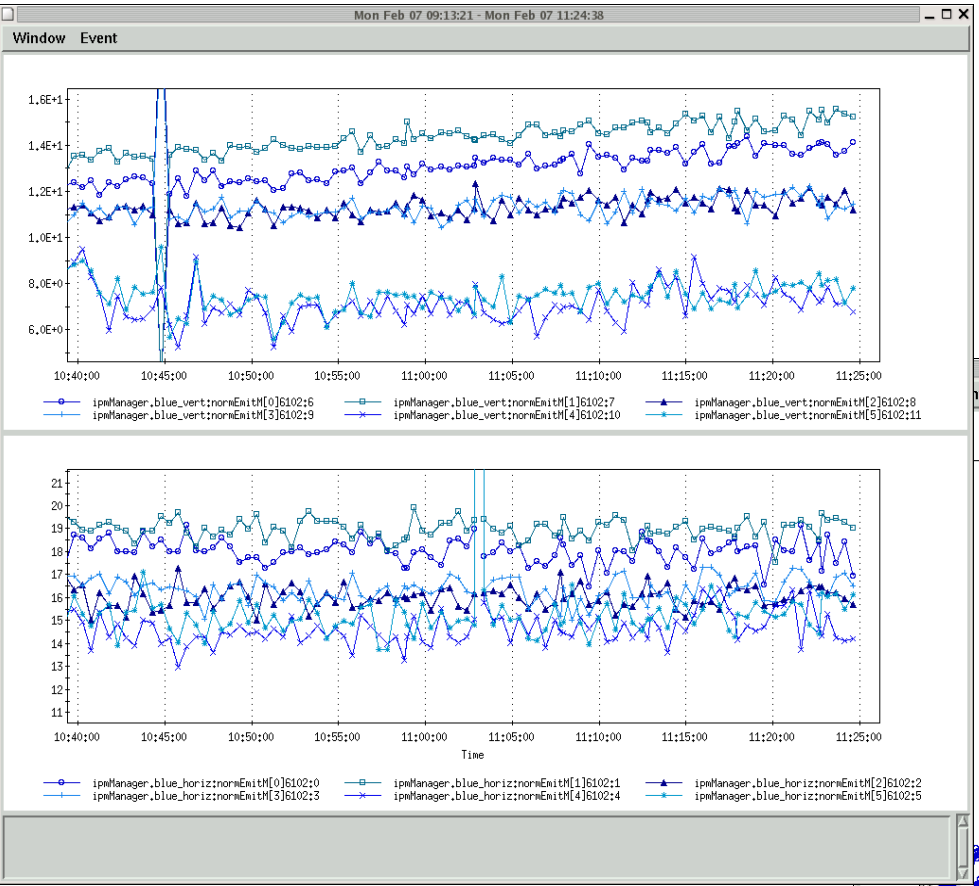
# IBS at Store in Blue

Wolfram, Alexei, Rob, SteveT, RogerC

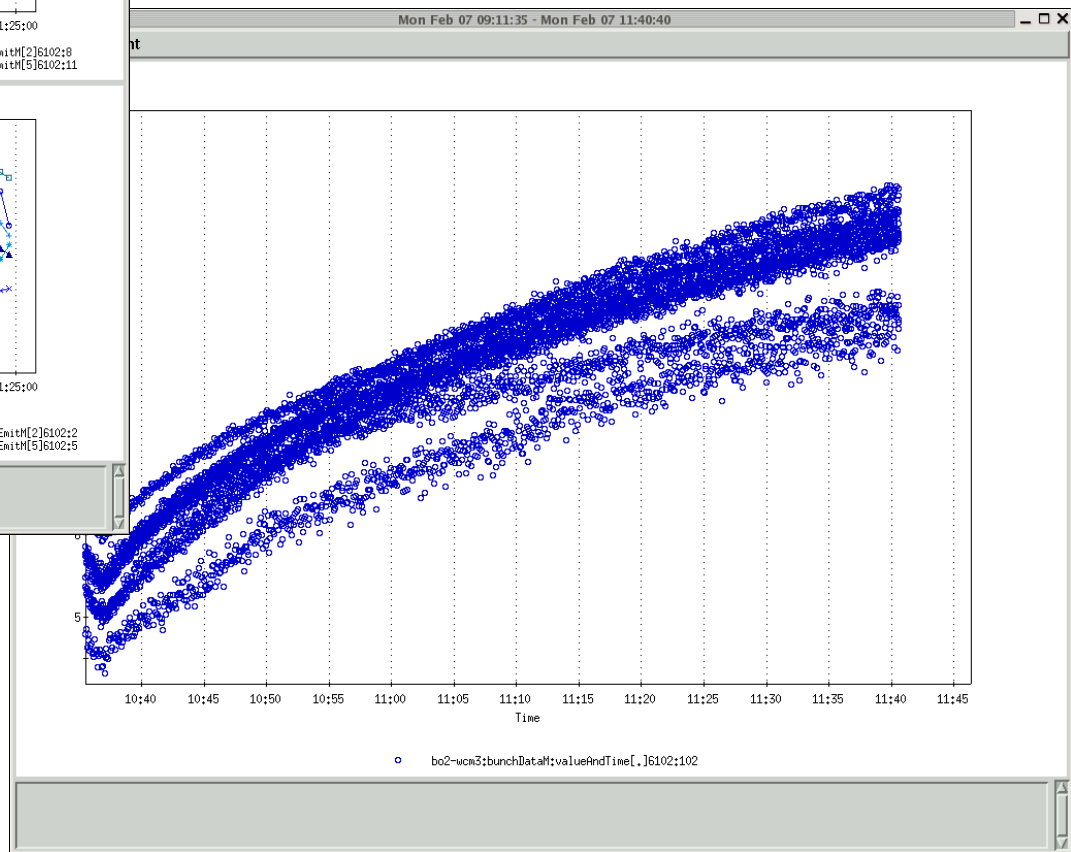
- Various intensity bunches
- Emittance, bunch length measured over time



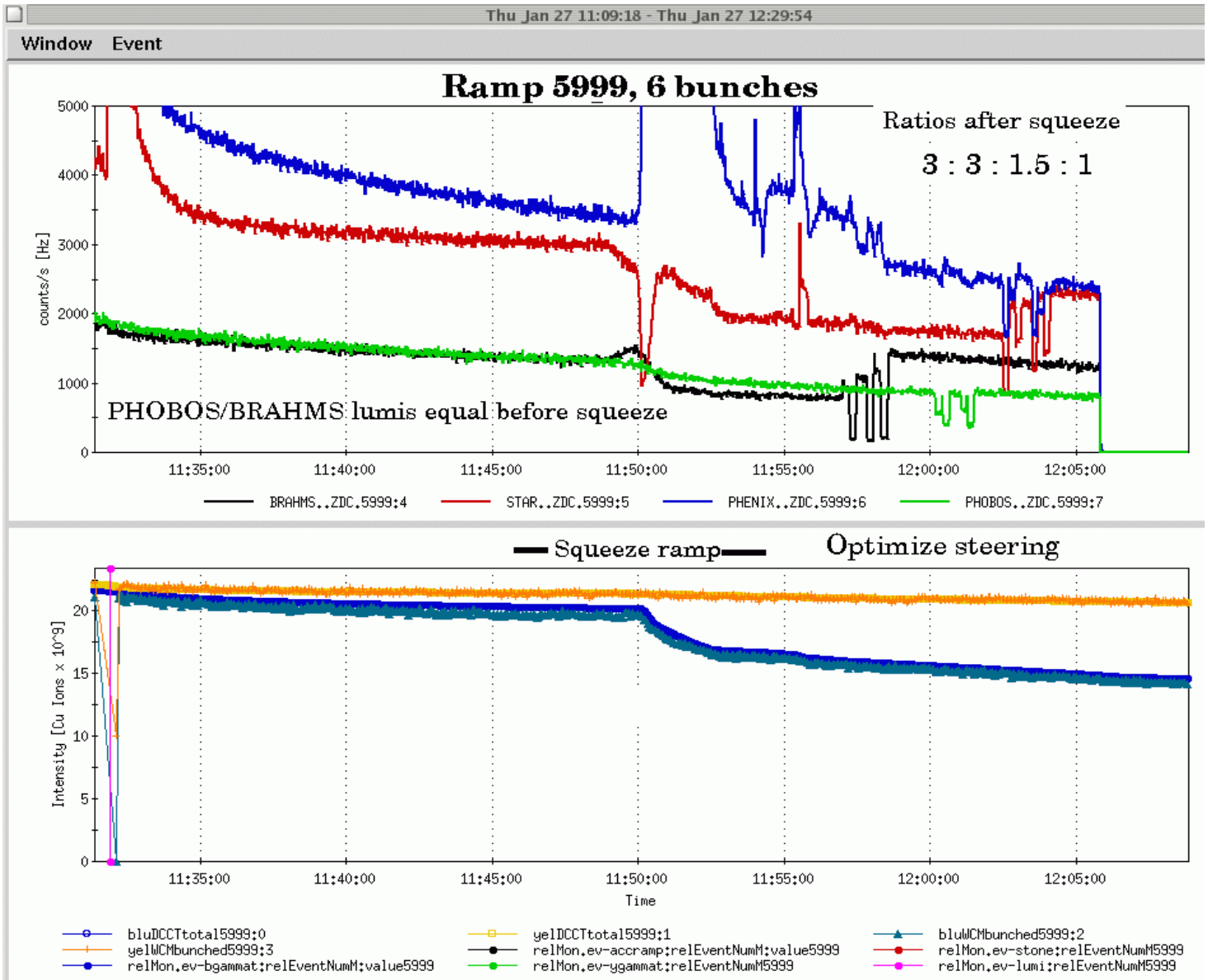
# IBS at Injection and Store




- Various intensity bunches
- Emittance, bunch length measured over time



# β* Squeeze for BRAHMS

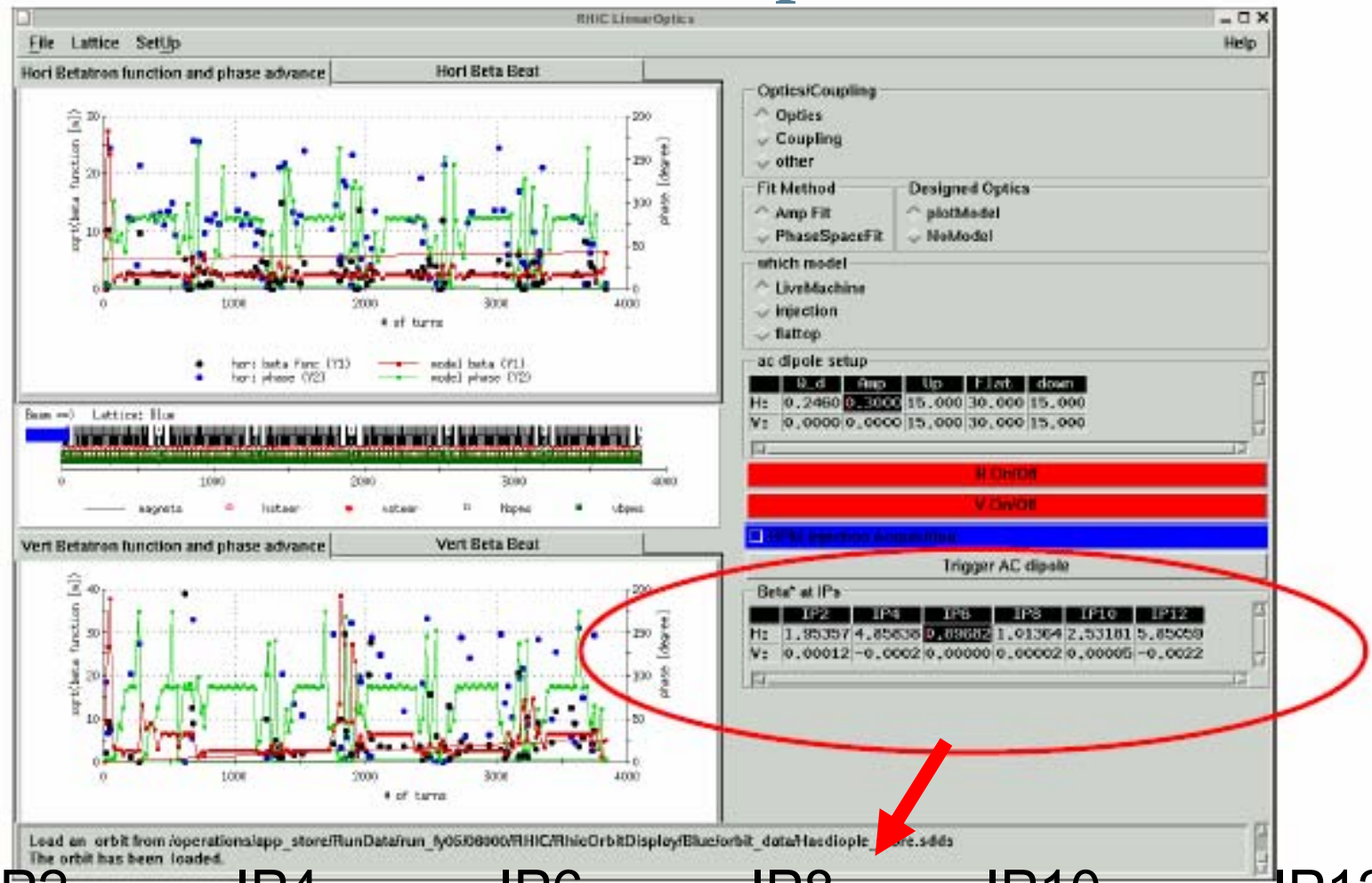



Fulvia, Todd, Nikolay, Mei, Steve

Ready to be used for operation

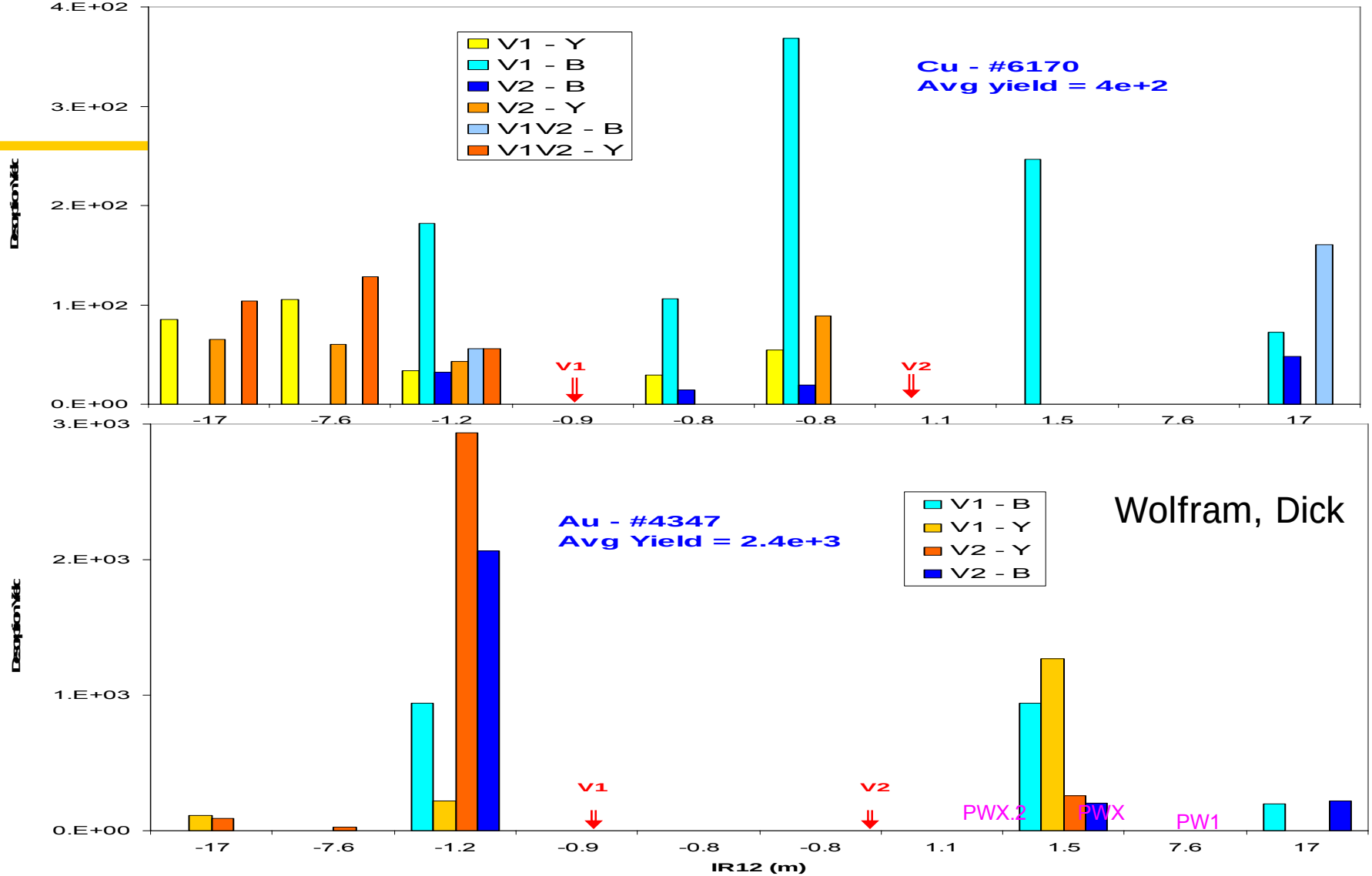
BROOKHAVEN NATIONAL LABORATORY

# $\beta^*$ Measurement with AC Dipole




| IP2 | IP4 | IP6 | IP8 | IP10 | IP12 |
|---|---|---|---|---|---|
| 1.884 | 4.858 | 0.883 | 1.001 | 2.527 | 5.925 |
| 0.051 | 0.003 | 0.011 | 0.010 | 0.009 | 0.125 |

BROOKHAVEN NATIONAL LABORATORY




**Rough estimate due to uncertainty of NEG pumping speed and gauge calibration**

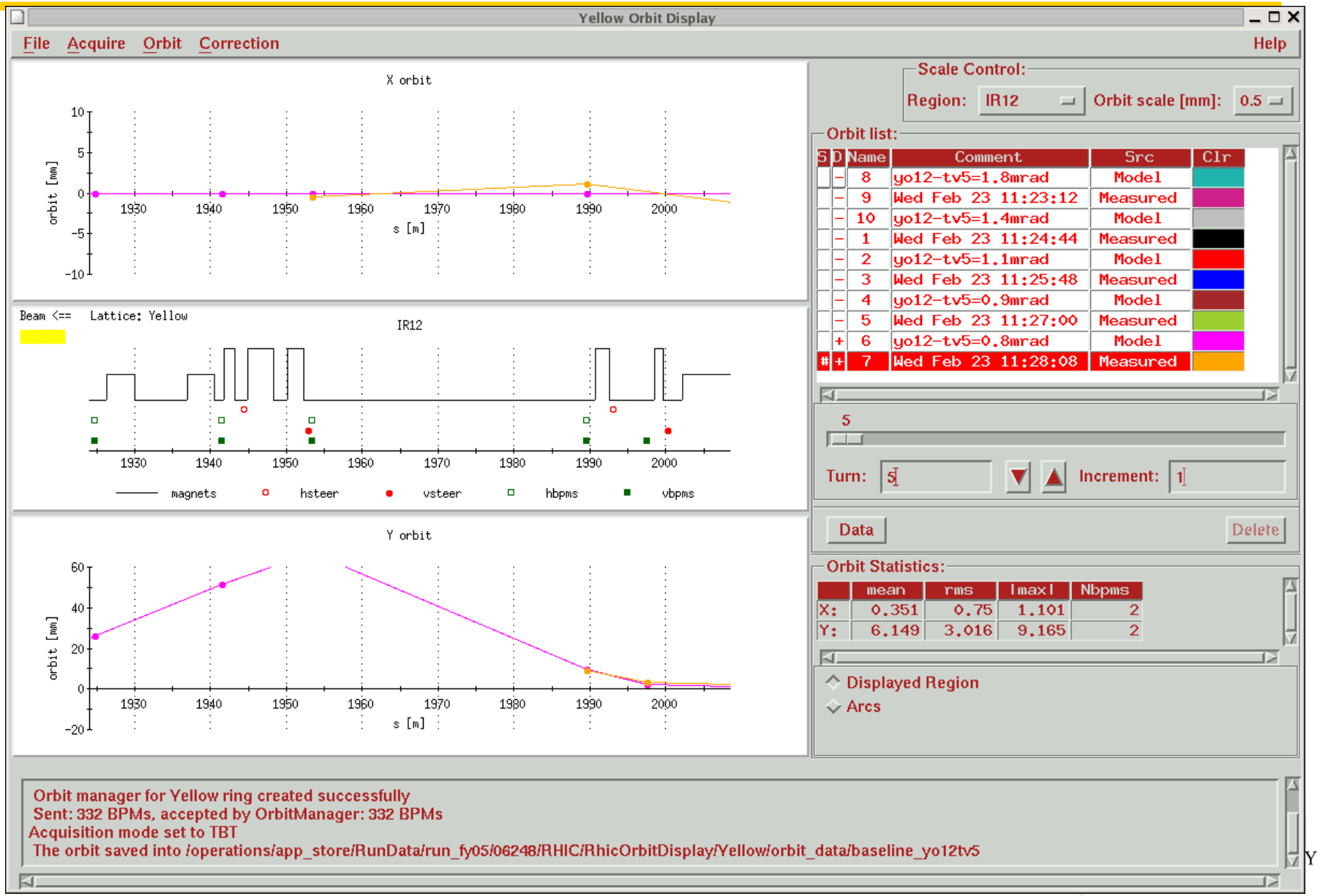
**$\eta_{Cu} << \eta_{Au}$ at normal incidence (IR12 gage valves)**

**$\eta_{Forward} >> \eta_{backward}$**

**Au desorption is more localized at the gate valves**

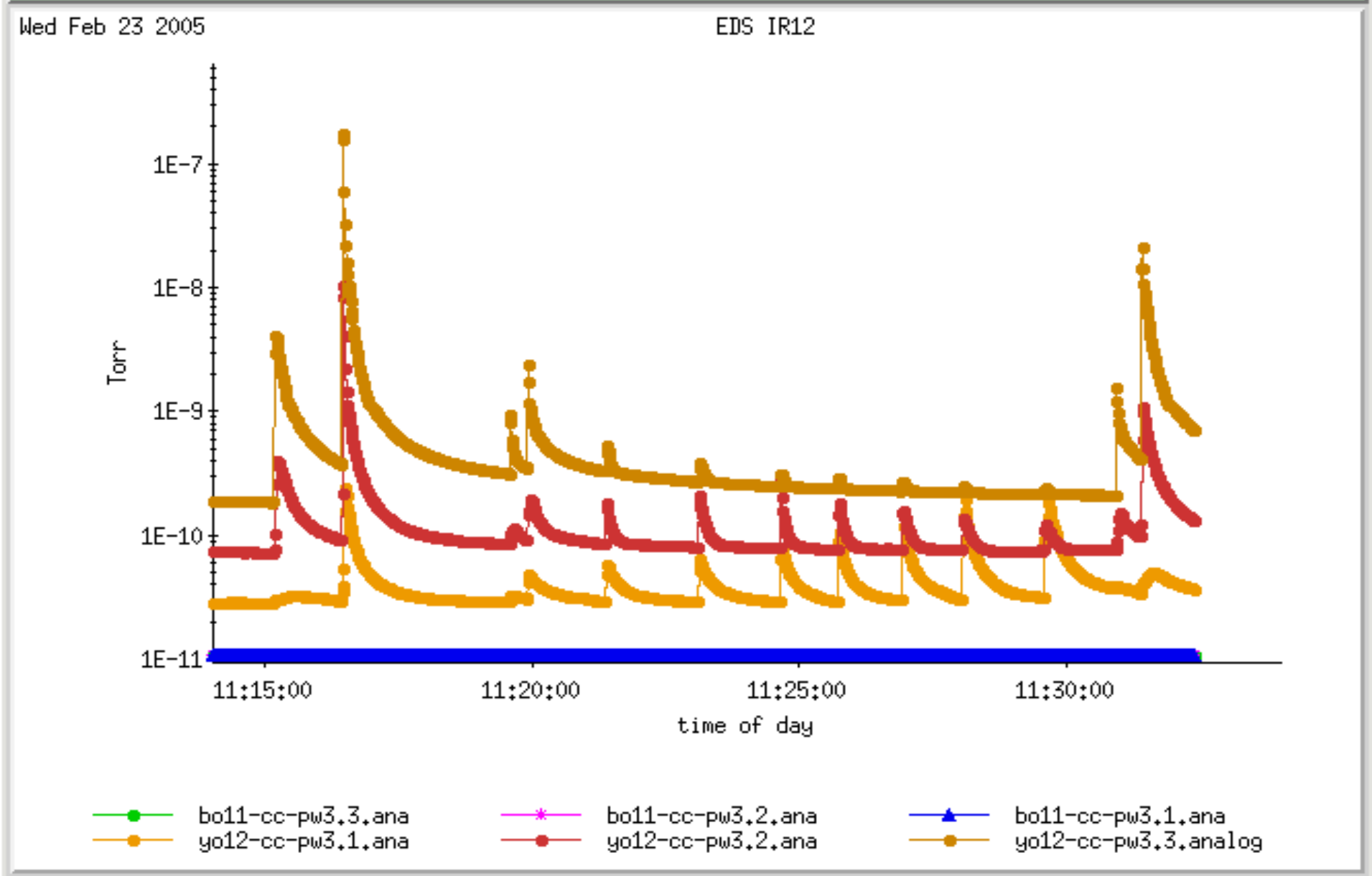
BROOKHAVEN NATIONAL LABORATORY

# NEG Evaluation



edsIR12.mon PPM User: RHIC_Cu_U1

File PPM Setup Logging Diagnostics




Message Area

Stop

# Effectiveness of anti-grazing ridges and NEG coating

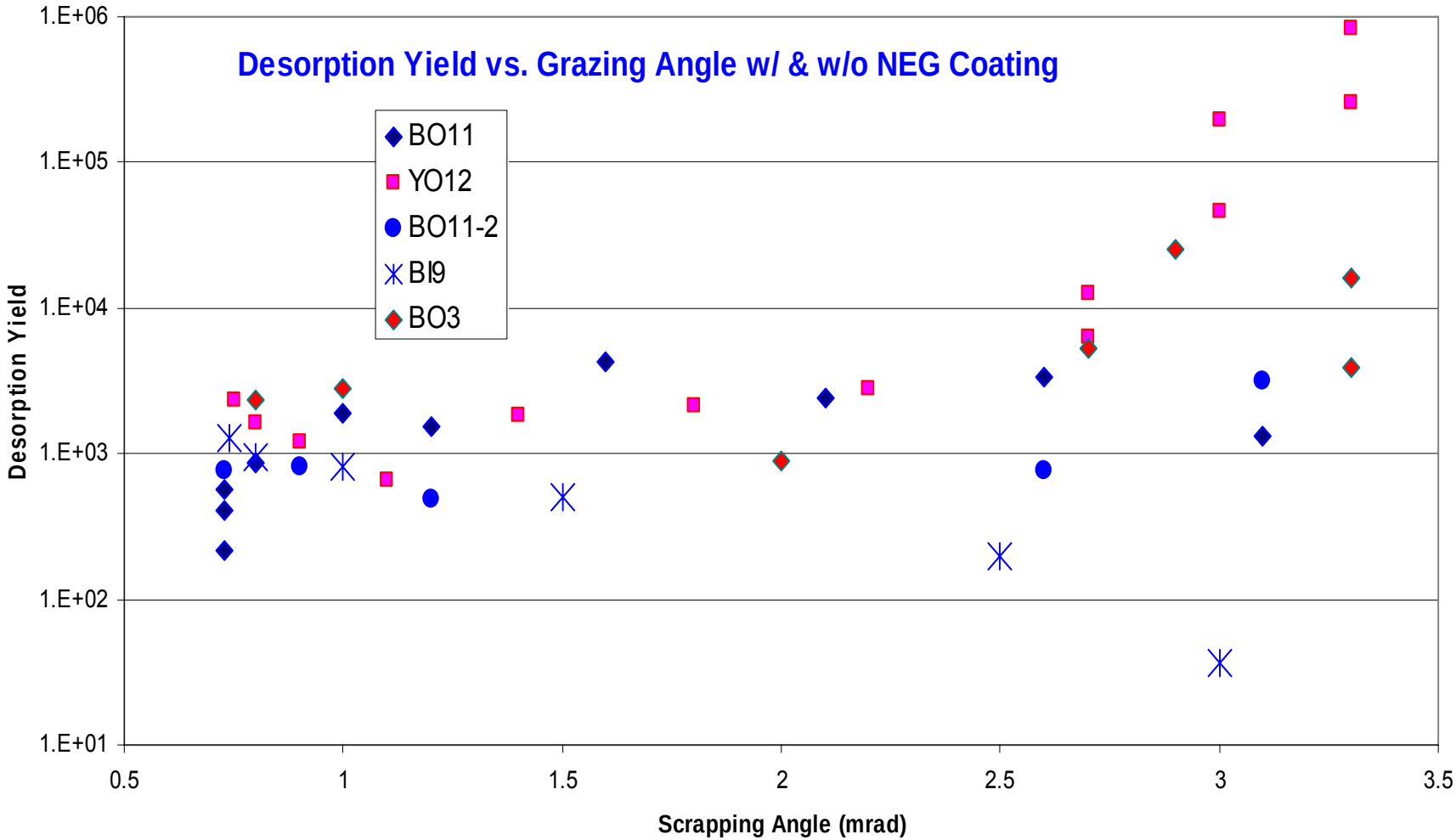
**# 6248 (Feb 23)**
**# 6343 (Mar 7)**
**(VP, HH, SY, PH, DH)**

BO11 & BI9 have NEG coating

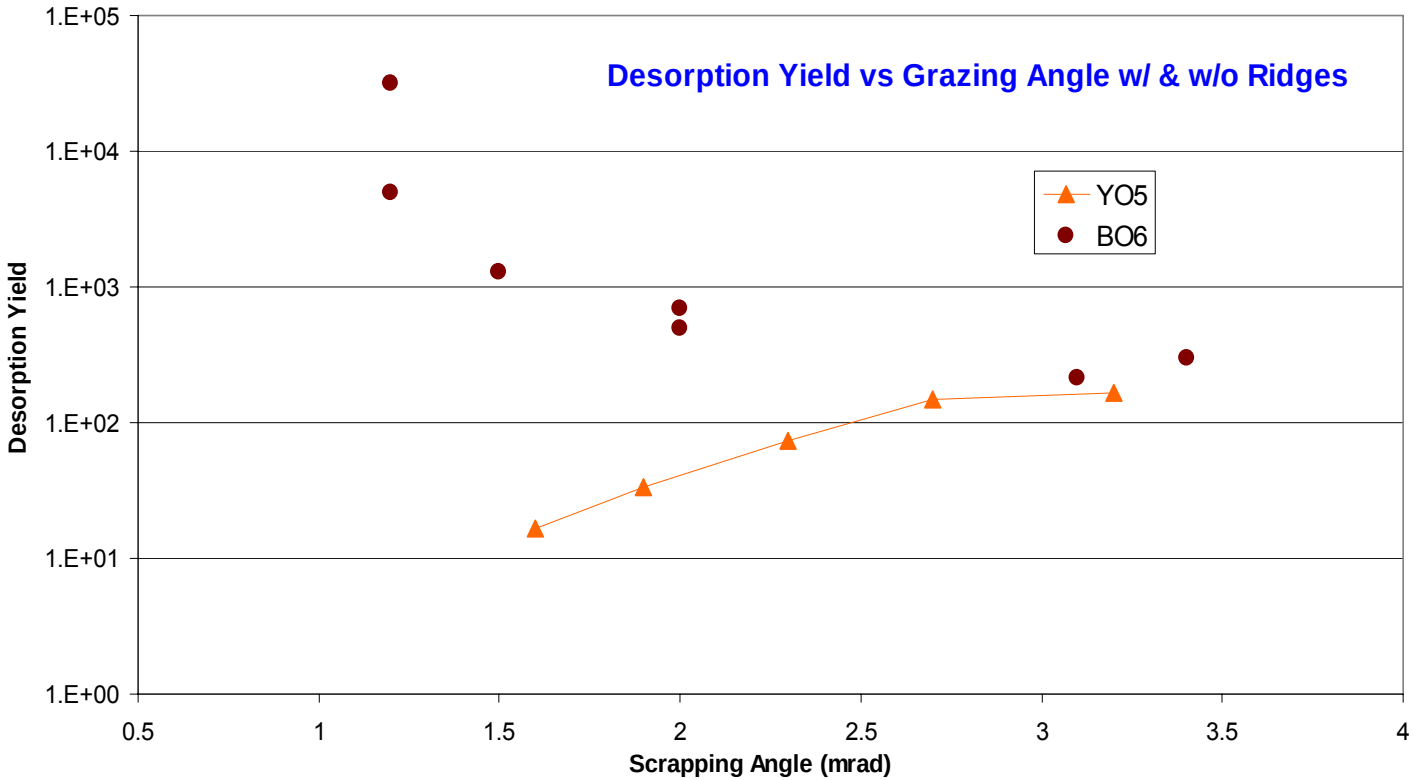
ΔP only at BO11 pw3.3 and BI9 pw3.1 (difficult to estimate η w/ NEG due to large pumping speed provided by NEG)

No observable pressure rise at BI5 (NEG + ridges)

η w/o NEG coating is higher especially at large Θ and at yo12 polarimeter (high $P_o$)



# Anti-Grazing Ridge




- BO6 desorption yield η proportional to 1/sinΘ?
- Ridges at YO5 reduce η at small Θ with desorption yield similar to that of gate valves
- BI5 (ridges + NEG) shows no ΔP at all

Summary:

η ~ 4e+2 for Θ = 90° (Cu on IR12 valves)

η ≥ e+3 for Θ = ~ mrad (YO12, BO3…)

Ridges helps η (YO5 vs. BO6)

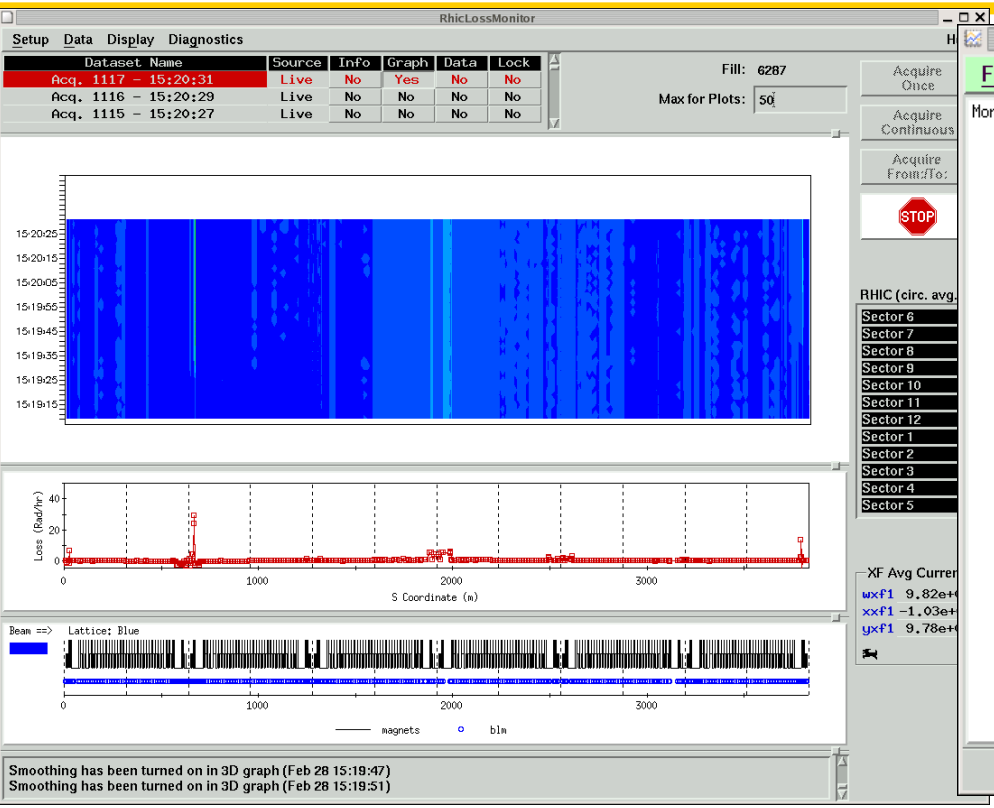
NEG coating helps η (BI5 vs. YO5 and BO6; BI9 and BO11 vs BO3)

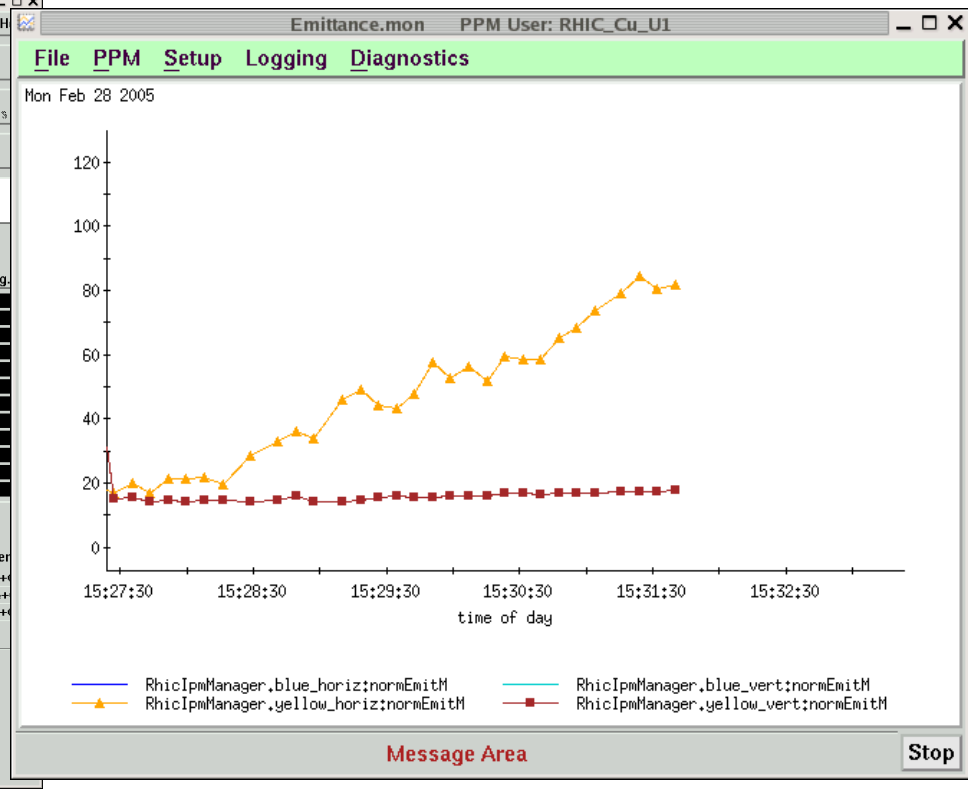
$\eta_P$ (e+2) < $\eta_{Cu}$ (e+3) < $\eta_{Au}$ (e+4)

Should we keep them but reduce their sizes (ones near Q3)?

# Estimation of Physical Aperture

Vadim,...)




Yellow horizontal -> 8 o'clock triplet

Yellow vertical -> the anti-grazing ridge (6 o'clock)

Blue horizontal -> the anti-grazing ridge

Blue vertical -> either 7 o'clock triplet or the anti-grazing ridge

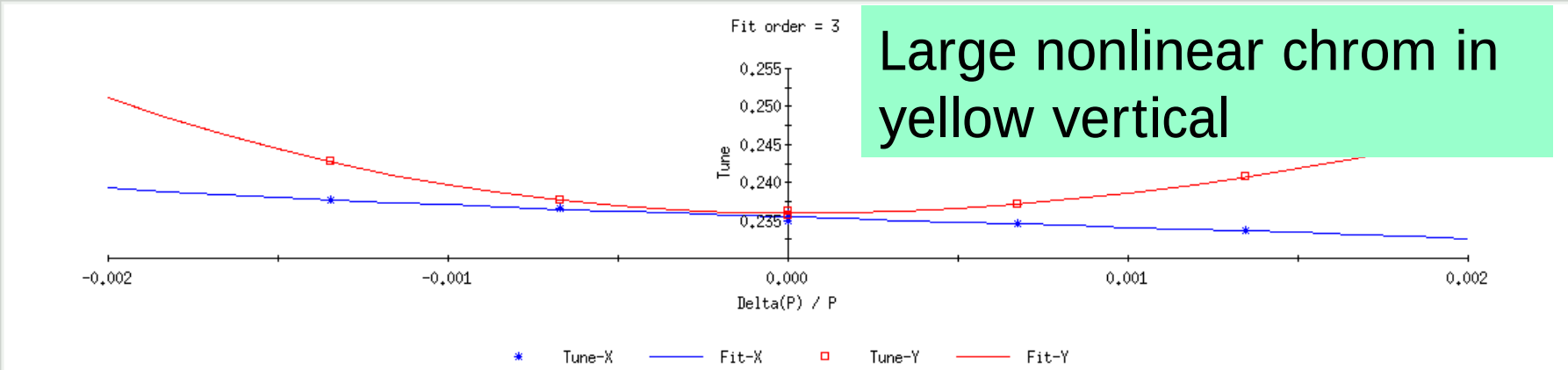
BROOKHAVEN NATIONAL LABORATORY

# Nonlinear Chromaticity at Store

Steve, Vadim

Analysis of Data -- Yellow ring -- Thu Jan 27, 2005 17:08:16

Tune vs. Momentum

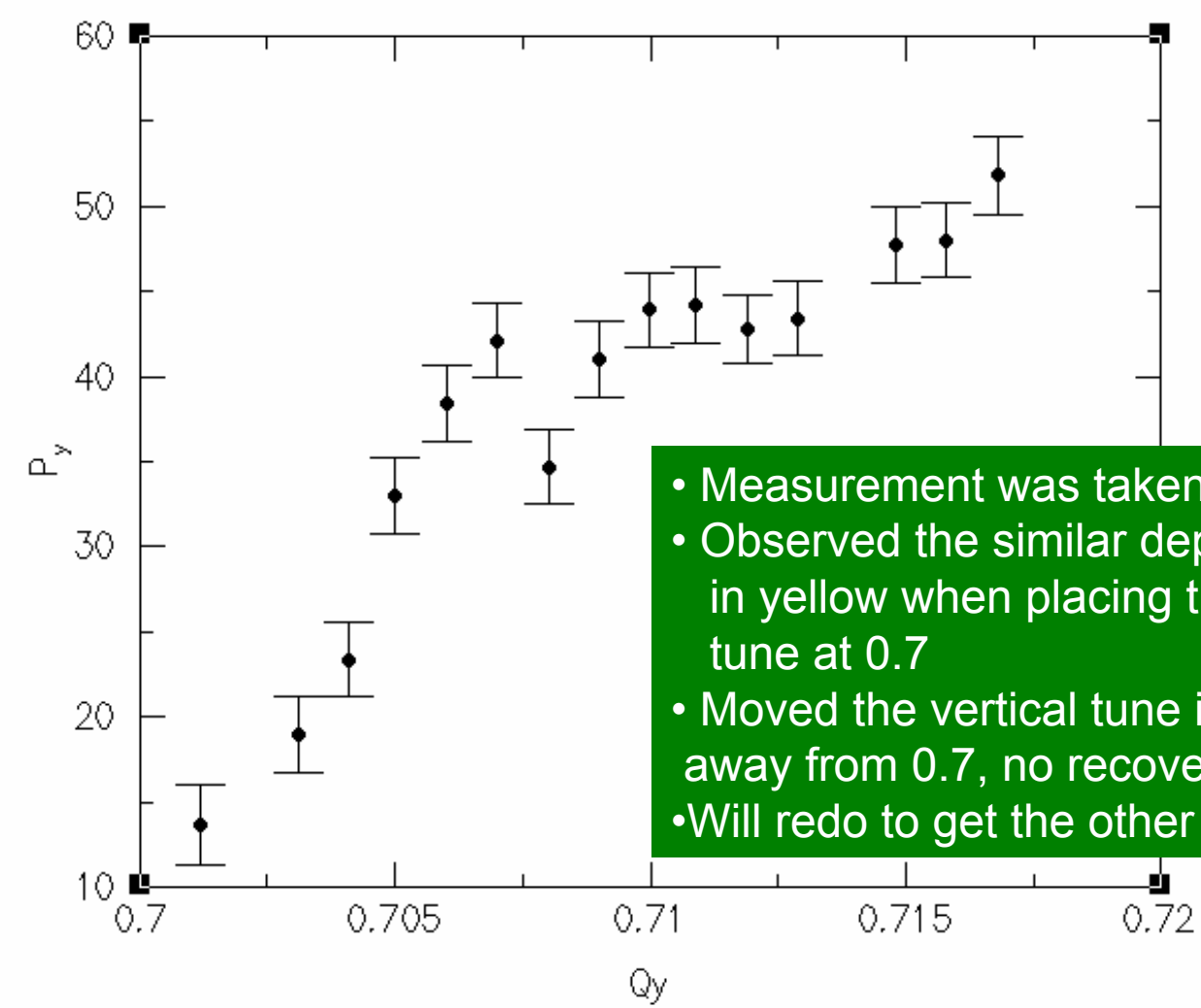



| Row | Delta(p)/p | PLL X | +- Sigma | Tune X #1 | Tune X #2 | Select | PLL Y | +- Sigma | Tune Y #1 | Tune Y #2 | Select |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.00134485 | 0.237696 | 0.000178978 | 0.237305 | 0.244141 | PLL | 0.242697 | 8.65817e-05 | 0.244141 | 0.170898 | PLL |
| 2 | -0.000671979 | 0.236539 | 0.000240549 | 0.235352 | 0.241211 | PLL | 0.237588 | 0.000189375 | 0.226562 | 0.37793 | PLL |
| 3 | 0 | 0.234974 | 2.76123e-05 | 0.235352 | 0.229492 | PLL | 0.235729 | 2.7923e-05 | 0.235352 | 0.376953 | PLL |
| 4 | 0 | 0.235846 | 3.93315e-05 | 0.235352 | 0.244141 | PLL | 0.236228 | 2.86892e-05 | 0.235352 | 0.151367 | PLL |
| 5 | 0.000672876 | 0.234602 | 0.000153771 | 0.234375 | 0.242188 | PLL | 0.237063 | 0.000238561 | 0.237305 | 0.217773 | PLL |
| 6 | 0.00134575 | 0.233599 | 0.000107498 | 0.234375 | 0.243164 | PLL | 0.240742 | 0.000147032 | 0.34082 | 0.164062 | PLL |
| 0 | 0 | 0 | 0 | 0 | 0 | PLL | 0 | 0 | 0 | 0 | PLL |
| 0 | 0 | 0 | 0 | 0 | 0 | PLL | 0 | 0 | 0 | 0 | PLL |
| 0 | 0 | 0 | 0 | 0 | 0 | PLL | 0 | 0 | 0 | 0 | PLL |
| 0 | 0 | 0 | 0 | 0 | 0 | PLL | 0 | 0 | 0 | 0 | PLL |
| 0 | 0 | 0 | 0 | 0 | 0 | PLL | 0 | 0 | 0 | 0 | PLL |

| | Corr | Tune | +-Sigma | Chrom[1] | +-Sigma | Chrom[2] | +-Sigma | Chrom[3] | +-Sigma |
|---|---|---|---|---|---|---|---|---|---|
| Horizontal | 0.981507 | 0.235457 | 0.000180828 | -1.41321 | 0.208248 | 114.403 | 235.125 | -60570.4 | 383540 |
| Vertical | 0.998247 | 0.235938 | 0.00010565 | -0.281648 | 0.12167 | 3187.44 | 137.373 | -247268 | 224085 |

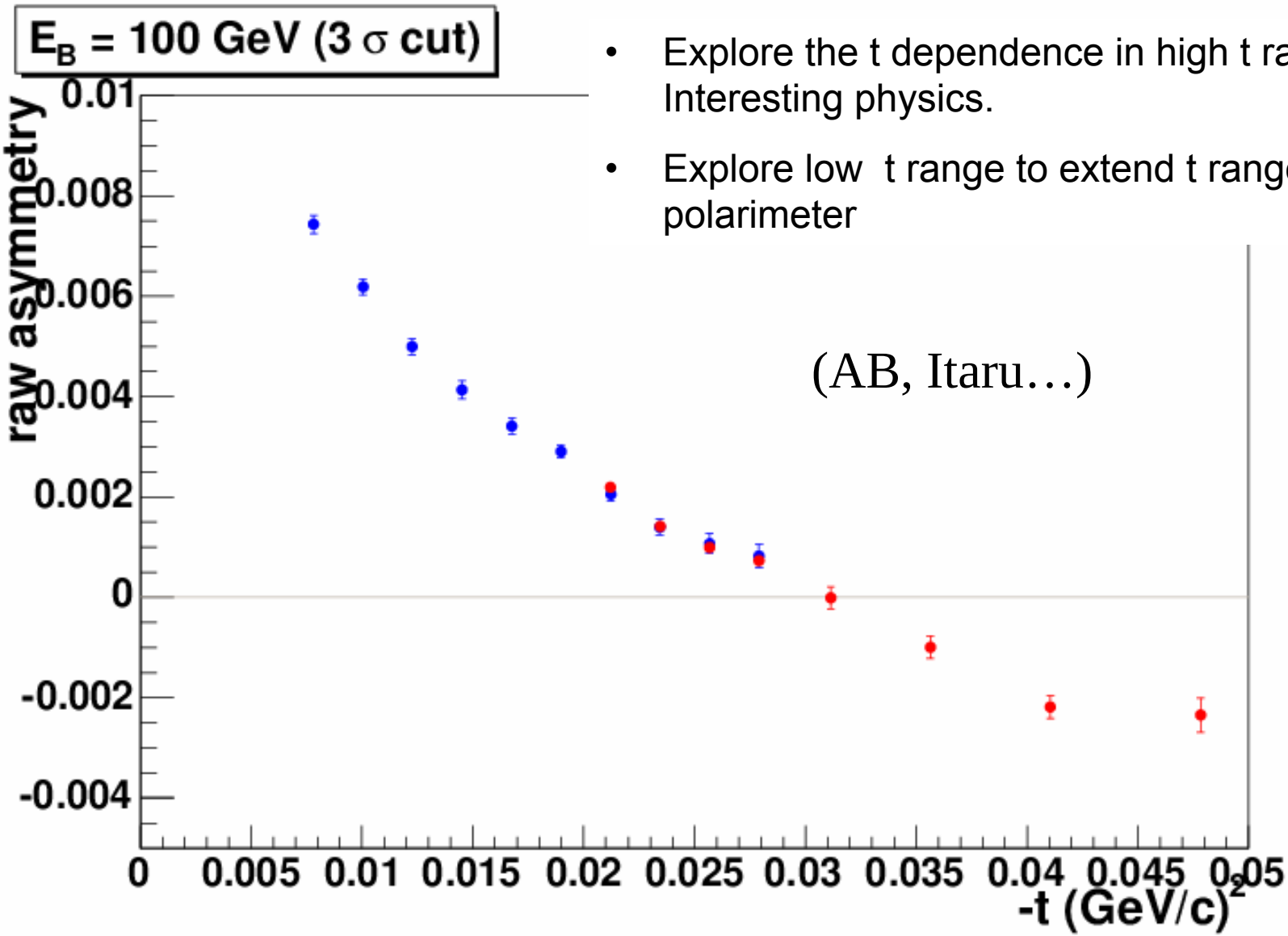
Set Peak #1 | Set PLL | Close

# Study the 0.7 Snake Resonance at Gγ=63




- Measurement was taken in blue ring
- Observed the similar depolarization in yellow when placing the vertical tune at 0.7
- Moved the vertical tune in yellow back away from 0.7, no recovery of polarization
- Will redo to get the other half of the spectrum

# Polarimeter Physics




- Explore the t dependence in high t range. Interesting physics.
- Explore low t range to extend t range of CNI polarimeter

(AB, Itaru…)

HAVEN
ABORATORY

# Other APEX

ZDC calibration

Loss Map for collimator development

Echo experiment

Non-linear IR correction

Schottky Calibration

Dispersion vs. Crossing Angle

Beam-Beam vs transverse separation

Optics IP2 for pp2pp

IPM test

# APEX in 2005

- Date moved to Monday day time now.
- BmEx Advanced to APEX.
- Most APEXs went through the AEAC for approval. There are few exceptions.
- The starting time becomes a flexible one during pp period.
- The APEX schedule is more or less a routine now. We have less or no complain from other experimenters.
- 12 hours/week is adequate for our current needs.
- Majority APEXs are RHIC operation oriented. Very few are for general accelerator physics.